

need stamina because they often spend much of the day on their feet and may do moderately heavy lifting.

Companies employing tool and die makers have traditionally operated only one shift per day. However, as the cost of new machinery and technology has increased, many employers now have more than one shift. Overtime and weekend work are common, especially during peak production periods.

Employment

Tool and die makers held about 138,000 jobs in 1998. Most worked in industries that manufacture metalworking machinery and equipment, motor vehicles, aircraft, plastics products, telecommunications equipment, and medical instruments. Although they are found throughout the country, jobs are most plentiful in the Midwest, Northeast, and West Coast, where many of the metalworking industries are located.

Training, Other Qualifications, and Advancement

Tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships, postsecondary programs, or informal on-the-job training. The best way to learn all aspects of tool and die making, according to most employers, is a formal apprenticeship program that combines classroom instruction and job experience. These programs are rare, however. A growing number of tool and die makers receive most of their formal classroom training from community and technical colleges.

Tool and die maker trainees learn to operate milling machines, lathes, grinders, and other machine tools. They also learn to use handtools for fitting and assembling gauges, and other mechanical and metal-forming equipment. In addition, they study metalworking processes such as heat treating and plating. Classroom training usually consists of mechanical drawing, tool designing, tool programming, blueprint reading, and mathematics courses, including algebra, geometry, trigonometry, and basic statistics. Tool and die makers increasingly must have good computer skills to work with CAD technology and CNC machine tools.

Workers who become tool and die makers without completing formal apprenticeships generally acquire their skills through a combination of informal on-the-job training and classroom instruction at a vocational school or community college. They often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers. In fact, tool and die makers are often considered highly specialized machinists. (See the statement on machinists and machine tool programmers elsewhere in the *Handbook*.)

Because tools and dies must meet strict specifications—precision to one ten-thousandth of an inch is common—the work of tool and die makers requires a high degree of patience and attention to detail. Good eyesight is essential. Persons entering this occupation should also be mechanically inclined, able to work and solve problems independently, and capable of doing work that requires concentration and physical effort.

There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms; some obtain their college degree and go into engineering; others become tool designers or machine tool programmers; and many start their own shops.

Job Outlook

Employment of tool and die makers is expected to decline through 2008. Nevertheless, jobseekers with the appropriate skills and background should enjoy excellent opportunities as employers across the Nation report difficulties in finding qualified workers to fill these positions. Moreover, many openings will be created each year by tool and die makers who retire. As more of these highly skilled workers retire, employers in certain parts of the country, who are already facing a shortage of workers, may face even more pronounced shortages, which will contribute to declining employment in the occupation.

Apart from a shortage of new entrants, the projected decline in employment reflects advancements in automation, including CNC machine tools and computer-aided design. CNC machine tools have made tool and die makers more productive, while CAD and CAM have allowed

some functions previously performed by these workers to be carried out by a computer and CNC programmer. Because precision metal products are a primary component of manufacturing machinery, increased imports of finished goods and precision metal products, including tools and dies, may lessen the demand for tool and die makers. However, these workers are highly skilled and play a key role in the operation of many firms. As firms invest in new equipment, modify production techniques, and implement product design changes more rapidly, they will continue to rely heavily on skilled tool and die makers for retooling. This fact, coupled with a growing demand for motor vehicles, aircraft, machinery, and other products that use machined metal parts, should help to moderate the decline in employment.

Earnings

Median annual earnings of tool and die makers were \$37,250 in 1998. The middle 50 percent earned between \$29,910 and \$45,240. The lowest 10 percent had earnings of less than \$23,960, while the top 10 percent earned over \$51,160. Median annual earnings in the manufacturing industries employing the largest number of tool and die makers in 1997 are shown below.

Motor vehicles and equipment	\$43,400
Aircraft and parts	39,800
Metal forgings and stampings	39,600
Miscellaneous plastics products	35,700
Metalworking machinery	34,600

Related Occupations

The occupations most closely related to the work of tool and die makers are other machining occupations. These include machinist, mold maker, instrument maker, metalworking and plastics-working machine operator, and machine tool programmer.

Other occupations that require precision and skill in working with metal include blacksmith, gunsmith, locksmith, metal patternmaker, and welder.

Sources of Additional Information

For information about careers in tool and die making, contact:

- ✦ The National Tooling and Machining Association, 9300 Livingston Rd., Ft. Washington, MD 20744. Internet: <http://www.ntma.org>
- ✦ Precision Metalforming Association, Tool & Die Division, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: <http://www.metalforming.com>
- ✦ Tooling and Manufacturing Association, 1177 South Dee Rd., Park Ridge, IL 60068. Internet: <http://www.tmanet.com>

Welders, Cutters, and Welding Machine Operators

(O*NET 91702, 91705, 93914A, 93914B, and 93914C)

Significant Points

- Training for welders can range from a few weeks of school or on-the-job training for low skilled positions to several years of combined school and on-the-job training for high skilled jobs.
- Job prospects should be excellent, as employers report a shortage of qualified applicants.

Nature of the Work

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufactured products. Welding is also

used to join beams when constructing buildings, bridges, and other structures, and to join pipes in pipelines, power plants, and refineries.

Welders and welding machine operators use many types of welding equipment in a variety of positions, such as flat, vertical, horizontal, and overhead. They may perform manual welding, in which the work is entirely controlled by the welder, or semi-automatic welding, in which the welder uses machinery, such as a wire feeder, to help perform welding tasks. Skilled welders generally plan work from drawings or specifications or by using their knowledge of welding and metals to analyze damaged metal parts. These workers then select and set up welding equipment and examine welds, to insure they meet standards or specifications. Some welders have more limited duties, however. They perform routine jobs that have already been planned and laid out and do not require extensive knowledge of welding techniques.

Automated welding is used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks, while monitored by a welding machine operator. Welding machine operators set up and operate welding machines, as specified by layouts, work orders, or blueprints. Operators must load parts correctly and constantly monitor the machine to ensure that it produces the desired weld.

The work of arc, plasma, and flame cutters is closely related to that of welders. However, instead of joining metals, cutters use the heat from burning gases or an electric arc to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators.

Working Conditions

Welders and cutters are often exposed to a number of potential hazards, including the intense light created by the arc, hazardous fumes, and burns. To protect themselves, they wear safety shoes, goggles, hoods with protective lenses, and other devices designed to prevent burns and eye injuries and for protection from falling objects. Automated welding machine operators are not exposed to as many dangers, however, and a face shield or goggles usually provides adequate protection for these workers.

Welders and cutters may work outdoors in inclement weather or indoors, sometimes in a confining area designed to contain sparks and glare. When outdoors, they may work on a scaffold or platform high off the ground. In addition, they may be required to lift heavy objects and work in a variety of awkward positions, having to make welds while bending, stooping, or working overhead.

Although the majority of welders work a 40-hour week, overtime is common, and some welders work up to 70 hours per week. Welders may also work in shifts as long as 12 hours.



Welders must be able to concentrate for long periods and have good hand-eye coordination.

Employment

Welders, cutters, and welding machine operators held about 477,000 jobs in 1998. Of these jobs, 3 of every 4 were held by welders and cutters, who worked mostly in manufacturing and services. The majority of those in manufacturing were employed in the transportation equipment, industrial machinery and equipment, or fabricated metal products industries. Those employed in the service sector worked mainly in repair shops and for personnel supply agencies. All welding machine operators were employed in manufacturing industries, primarily fabricated metal products, machinery, and motor vehicles.

Training, Other Qualifications, and Advancement

Training for welders can range from a few weeks of school or on-the-job training for low skilled positions to several years of combined school and on-the-job training for highly skilled jobs. Formal training is available in high schools, vocational schools, and post secondary institutions, such as vocational-technical institutes, community colleges, and private welding schools. The Armed Forces operate welding schools as well. Some employers provide training to help welders improve their skills. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful. Knowledge of computers is gaining importance, especially for welding machine operators, as some welders are becoming responsible for the programming of computer-controlled welding machines, including robots.

Some welders become certified, a process whereby the employer sends a worker to an institution, such as an independent testing lab or technical school, to weld a test specimen to specific codes and standards required by the employer. Testing procedures are based on the standards and codes set by one of several industry associations with which the employer may be affiliated. If the welding inspector at the examining institution determines that the worker has performed according to the employer's guidelines, the inspector will then certify the welder being tested as able to work with a particular welding procedure.

Welders and cutters need good eyesight, hand-eye coordination, and manual dexterity. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions. In addition, welders increasingly need to be willing to receive training and perform tasks in other production jobs.

Welders can advance to more skilled welding jobs with additional training and experience. For example, they may become welding technicians, supervisors, inspectors, or instructors. Some experienced welders open their own repair shops.

Job Outlook

Despite projected slower-than-average employment growth, job prospects should be excellent for welders with the right skills, as many employers report difficulties in finding qualified applicants. In addition, openings will arise as workers retire or leave the occupation for other reasons.

Employment of welders, cutters, and welding machine operators is expected to grow more slowly than the average for all occupations through 2008, reflecting rising automation and productivity in many of the industries that employ these workers. The major factor affecting employment of welders is the health of the industries in which they work. Because almost every manufacturing industry uses welding at some stage of manufacturing or in the repair and maintenance of equipment, a strong economy will keep demand for welders high. A downturn affecting such industries as auto manufacturing, construction, or petroleum, however, would have a negative impact on the employment of welders in those areas and could cause some layoffs. Government funding levels for infrastructure repairs and improvements is also expected to be an important determinant of future welding jobs.

Regardless of the state of the economy, the shortage of welders and drive to increase productivity and cut costs is leading many companies to invest more in automation, especially computer-controlled and robotically-controlled welding machinery. This may affect the demand for low-skilled manual welders, as the jobs that are currently

being automated are the simple, repetitive ones. The growing use of automation, however, should increase demand for welding machine operators. Welders working on construction projects or in equipment repair will not be as affected, because their jobs are not as easily automated.

Technology is helping to improve welding and create more uses for welding in the workplace. For example, new ways are being developed to weld dissimilar materials and nonmetallic materials, such as plastics, composites, and new alloys. Also, laser beam welding and other techniques are improving the results of welding and making it applicable to a wider assortment of jobs. The effect of technological innovation on the overall use of welding is unclear, however, because other processes designed to replace welding and make welders more productive, such as new adhesive technologies and high-speed machining, will contribute to decreasing demand for these workers.

Earnings

Median annual earnings of welders and cutters were \$25,810 in 1998. The middle 50 percent earned between \$21,440 and \$32,020. The lowest 10 percent had earnings of less than \$17,550, while the top 10 percent earned over \$39,650. Median annual earnings in the industries employing the largest number of welders and cutters in 1997 were:

Ship and boat building and repairing	\$27,200
Construction and related machinery	25,300
Motor vehicles and equipment	24,700
Fabricated structural metal products	23,800
Miscellaneous repair shops	22,600

Median annual earnings of welding machine operators were \$25,010 in 1998. The middle 50 percent earned between \$20,820 and \$31,270. The lowest 10 percent had earnings of less than \$16,870, while the top 10 percent earned over \$39,710. Median annual earn-

ings in the industries employing the largest number of welding machine operators in 1997 were:

Construction and related machinery	\$26,100
Metal forgings and stampings	24,100
Motor vehicles and equipment	23,700
Fabricated structural metal products	22,400
Miscellaneous fabricated metal products	20,500

More than one-fourth of welders belong to unions. Among these are the International Association of Machinists and Aerospace Workers; the International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada; and the United Electrical, Radio, and Machine Workers of America.

Related Occupations

Welders and cutters are skilled metal workers. Other metal workers include blacksmiths, forge shop workers, machinists, machine-tool operators, tool and die makers, millwrights, sheet-metal workers, boiler-makers, and metal sculptors.

Welding machine operators run machines that weld metal parts. Others who run metalworking machines include lathe and turning, milling and planing, punching and stamping press, and rolling machine operators.

Sources of Additional Information

For information on training opportunities and jobs for welders, cutters, and welding machine operators, contact local employers, the local office of the State employment service, or schools providing welding training.

Information on careers in welding is available from:

✦ American Welding Society, 550 N.W. Lejeune Rd., Miami, FL 33126-5699. Internet: <http://www.aws.org>

Plant and Systems Operators

Electric Power Generating Plant Operators and Power Distributors and Dispatchers

(O*NET 95021, 95023, 95026, and 95028)

Significant Points

- Overall employment of operators, distributors, and dispatchers is expected to decline, as deregulation and increasing competition cause the electric utility industry to restructure and cut jobs.
- Job losses will not be offset by new power plants because their greater automation requires fewer operators, and plant construction is expected to slow due to concerns about electric power generating overcapacity.
- Shrinking employment and low turnover of operator positions will decrease advancement opportunities for helpers and laborers.

Nature of the Work

Electricity is vital for most of our everyday activities. From the moment you flip the first switch each morning, you are connecting to a huge network of people, electric lines, and generating equipment. Electric power generating plant operators control the machinery that generates electricity. Power distributors and dispatchers control the

flow of electricity, from the power plant over a network of transmission lines to industrial plants and substations, and finally over distribution lines to residential users.

Electric power generating plant operators control and monitor boilers, turbines, generators, and auxiliary equipment in power generating plants. Operators distribute power demands among generators, combine the current from several generators, and monitor instruments to maintain voltage and regulate electricity flows from the plant. When power requirements change, these workers start or stop generators and connect or disconnect them from circuits. They may use computers to keep records of switching operations and loads on generators, lines, and transformers. Operators may also use computers to prepare reports of unusual incidents, malfunctioning equipment, or maintenance performed during their shift.

Operators in plants with automated control systems work mainly in a central control room and usually are called *control room operators* and *control room operator trainees* or *assistants*. In older plants, the controls for the equipment are not centralized, and *switchboard operators* control the flow of electricity from a central point, whereas *auxiliary equipment operators* work throughout the plant, operating and monitoring valves, switches, and gauges.

The Nuclear Regulatory Commission (NRC) licenses operators of nuclear power plants. *Reactor operators* are authorized to control equipment that affects the power of the reactor in a nuclear power plant. In addition, an NRC-licensed *senior reactor operator* acts as the supervisor of the plant for each shift and supervises operation of all controls in the control room.

Power distributors and dispatchers, also called *load dispatchers* or *systems operators*, control the flow of electricity through transmission lines to industrial plants and substations that supply residential electric